T.E- CHEM/CBGS/V/HTO-:

QP Code : 3393

Heat Transfer Operation I

(3 Hours) [Total Marks : 80

(1) Question no. 1 is compulsory
(2) Attempt any **three** questions from the remaining **five.**
(3) **All** questions carry **equal** marks.
(4) **Make** suitable **assumptions** if necessary and state them clearly.

(a) A person is found dead at 5 pm in a room whose temperature is 20°C. The temperature of the body is measured to be 25°C, when found and the heat transfer coefficient is estimated to be h= 8 W/m² °C. Modelling the body as 30cm diameter, 1.7m long cylinder estimate the time of death of that person. 5

(b) It is necessary to insulate a flat surface 50 that the rate of heat loss per unit area of this surface does not exceed 450 W/m². The temperature difference across the insulating layer is 400K. Evaluate the thickness of insulation if 5

(i) The insulation is made of asbestos cement having a thermal conductivity of 0.11 W/mK.

(ii) The insulation is made of fire clay having a thermal conductivity of 0.84 W/m K

(c) State assumption made in Nusselt's theory of condensation 5

(d) What is fin efficiency and what is fin effectiveness? 5

(a) Steam at 320° C flows in a cast iron pipe (k=80W/m °C) whose inner and outer diameters are D_1 =5cm and D_2 =5.5cm respectively. The pipe is covered with 3cm thick glass wool insulation with k=0.05 W/m°C. Heat is lost to the surrounding at 5°C by natural convection and radiation with a combined heat transfer coefficient h_2 =18 W/m² °C. Taking the heat transfer coefficient inside the pipe to be 60W/m² °C, determine the rute of hat loss from the steam per unit length of the pipe. Also determine the temperature drop across the pipe shell and the insulation. 10

(b) 250mm diameter circular disc is exposed to atmospheric air at 298K One surface of a disc is insulated and other surface is maintained at 403K. Calculate the amount of heat transferred from the disc when it is 10

(i) Horizontal, with hot surface facing up

(ii) Horizontal with hot surface facing down.

Data:- The properties of air at mean film temp. are

kinetic viscosity = $2\times10^{-5}\,m^2/s$. Pr No. = 0.7 k=0.3 W/mK, L=0.9 D

(a) For heat transfer by forced convention show that Nussedt number is function of Reynold number and prandtl number 10

(b) Water at 600 flows at a rate of 10kg/s through a pipe with a 7.5 cm inside diameter Find the heat transfer coefficient using (i) The colburn analogy (ii) The prandtl analogy (iii) The von-karman analogy 10

[TURN OVER

4. (a) One end of a very long aluminium rod of 3mm in diameter is connected to a wall at 140° C while the other end prodrudes into a room whose air temperature is 288K. Determine the total heat dissipated by a rod. **10**

k for aluminium = 150 W/mK

h between rod surfaces and environment = 300W/mK

(b) Two large parallel plates of emiviteis 0.1 and 0.05 at absolute temperature of 350K and 300K are situated 2.5mm apart in air. Calculate the total heat transfer per unit area. **10**

Data: k air = 0.026W/mK

$\sigma = 5.67\times10^{-8}\,W/m^2K^4$

5. 0.5 kg/sec of ethylene glycol flows through a thin walled copper tube of 1.25 cm diameter. 0.375 kg/s of water flows in the opposite direction through the annular space formed by this tube and a tube of diameter 2cm. The ethylene glycol, which enters at 100°C is required to leave at 60°C, while the water enters at 10°C. **20**

Calculate the length of heat exchanger required Neglect resistance of copper tube wall.

The properties of water and ethyle glycol at at their bulk temperatures are listed below.

Property	Ethyle glycol at 80°C	Water at 27°C.
ρ (kg/m³)	1078	995
μ (kg/m.s)	3200×10^{-6}	853×10^{-6}
C_p(kJ/kg K)	2650	4180
k(W/m K)	0.261	0.614

Assume tube are clean so fouling is zero.

6. (a) Define:- (i) Wein's displacement law
(ii) Plank's law
(iii) Monochromatic emissive power
(iv) Monochromatic emissivity
(v) Grey body **10**

(b) Explain different regimes of boiling

7. (a) Derive a relation between effectiveness and NTU for a counter current heat exchanger **10**

(b) Dry steam at 373K condenses on the outside surface of horizontal pipe of 25mm OD. The pipe surface is maintained at 357K by circulating water through it. Determine mean average heat transfer coefficient, heat transfer per unit length of pipe. The properties of condensate at the film temperature of 350K are **10**

$\mu = 306\times10^{-6}\,N-s/m^2 \quad k = 0.66\,W/m\,K$

$\rho = 974\,kg/m^3, \lambda = 2225\,kJ/kg$
